ANANDALAYA
PERIODIC TEST - 1
Class : XII

विद्या सवर्धि साधिका

Subject: Physics MM : 40
Date : 21-07-2023 Time: 1 hour 30 min.

General Instructions:
1. There are 20 questions in all. All questions are compulsory.
2. This question paper has five sections: Section A, Section B, Section C, Section D and Section E. All the sections are compulsory.
3. Section A consists of twelve MCQs of 1 mark each, Section B consists of two questions of 2 marks each, Section C consists of two questions of 3 marks each, Section D consists of two long questions of 5 marks each and Section E consists of two case study based questions of 4 marks each.
4. There is no overall choice. However, an internal choice has been provided in section D and E. You have to attempt only one of the choices in such questions.
5. Use of calculators is not allowed.

SECTION A

1. The SI unit of electric field is ___________ (1)
(A) V (B) Vm (C) V/m (D) m/V

2. A electric dipole with charges +q and –q separated by a distance l . What is its electric dipole moment? (1)
(A) $+ql$ (B) $-ql$ (C) $2ql$ (D) zero

3. Three charges +6q, -2q, +3q are enclosed by a surface. The total electric flux passing through the surface is _________. (1)
(A) $\frac{6q}{\varepsilon_0}$ (B) $-\frac{2q}{\varepsilon_0}$ (C) $\frac{3q}{\varepsilon_0}$ (D) $\frac{7q}{\varepsilon_0}$

4. The capacitance of a capacitor has to be increased from 6μF to 30μF. How will you increase it? (1)
(A) By increasing the distance between the plates by 5 times.
(B) By decreasing the distance between the plates by 4 times.
(C) By introducing a dielectric medium of dielectric constant 5.
(D) By introducing a dielectric medium of dielectric constant 4.

5. A positively charged particle is released from rest in a uniform electric field. The electric potential energy of the charge __________________. (1)
(A) remains constant because the electric field is uniform.
(B) increases because the charge moves along the electric field.
(C) decreases because the charge moves along the electric field.
(D) decreases because the charge moves opposite to the electric field.

6. 'n' number identical cells of emf ε and internal resistance r are connected in series to get maximum emf. If one of the cells is connected wrongly, what will be the effective emf? (1)
(A) ε (B) nε (C) (n-1)ε (D) (n-2)ε

7. An electric dipole with dipole moment 4×10^{-9} C m is aligned at 30° with the direction of a uniform electric field of magnitude 5×10^{4} NC^{-1}. Calculate the magnitude of the torque acting on the dipole. (1)
(A) 10×10^{-5} Nm (B) 20×10^{-5} Nm (C) $10\sqrt{3} \times 10^{-5}$ Nm (D) 5×10^{-5} Nm

8. Two identical insulated charged copper spheres A and B have their centres separated by a distance of 50 cm. They repel each other with force F. A third sphere of the same size but uncharged is brought in contact with the first, then brought in contact with the second, and finally removed from both. What is the new force of repulsion between A and B? (1)

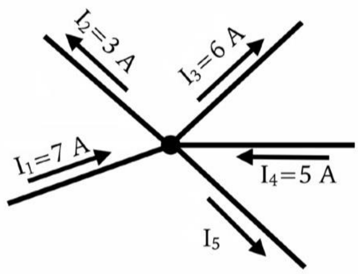
(A) $\frac{3}{2}F$ (B) $\frac{3}{4}F$ (C) $\frac{3}{8}F$ (D) F

9. A stationary charge 2×10^{-9} C is accelerated through a potential difference of 4×10^{4} V. What will be the kinetic energy of the charge? (1)

(A) 2×10^{13} J (B) 8×10^{-5} J (C) 4×10^{-5} J (D) 4×10^{4} J

10. What is the magnitude of the current I_5? (1)

(A) 15 A (B) 3A
(C) 5A (D) 6A



Questions 11 and 12 are assertion – reason type questions. Read the two statements given and choose if

(A) Both the assertion and reason are true and the reason is the correct explanation for the assertion.
(B) Both the assertion and reason are true but the reason is not the correct explanation for the assertion.
(C) Assertion is true but the reason is false.
(D) Both assertion and reason are false

11. Assertion: Dielectric polarisation means formation of positive and negative charges inside the dielectric. (1)
Reason: Free electrons are formed in this process.

12. Assertion: The conductivity of metal decreases with increase in temperature. (1)
Reason: With rise in the temperature the thermal speed of free electrons and amplitude of lattice vibration in a metal will increase resulting in increase in the rate of collision between free electrons and lattice.

SECTION B

13. Two charges 3×10^{-8} C and -2×10^{-8} C are located 15 cm apart. At what point on the line joining the two charges is the electric potential zero? Take the potential at infinity to be zero. (2)

14. A cell of emf E and internal resistance r is connected across a variable resistor R. Plot rough graphs showing the variation of the terminal voltage V with (a) R and (b) circuit current I. (2)

SECTION C

15. State Gauss's theorem in electrostatics. Prove that no electric field exists inside a hollow charged sphere. (3)

16. (a) A comb run through one's dry hair attracts small bits of paper. Why? What happens if the hair is wet or if it is a rainy day? (Remember, a paper does not conduct electricity.) (3)
(b) Ordinary rubber is an insulator. But special rubber tyres of aircraft are made slightly conducting. Why is this necessary?
(c) A bird perches on a bare high power line, and nothing happens to the bird. A man standing on the ground touches the same line and gets a fatal shock. Why?

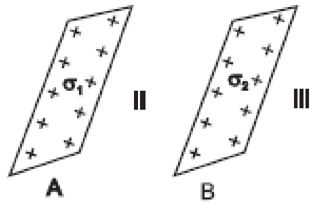
SECTION D

17. Deduce an expression for the electric potential due to an electric dipole at any point on its axis. Mention one contrasting feature of electric potential of a dipole at a point as compared to that due to a single charge. (5)

OR

A dielectric slab of thickness *t* is introduced without touching between the plates of a parallel plate capacitor, separated by a distance *d* ($t < d$). Derive an expression for the capacitance of the capacitor.

18. (a) Two infinitely large plane thin parallel sheets having surface charge densities σ_1 and σ_2 ($\sigma_1 > \sigma_2$) are shown in the figure. Write the magnitudes and directions of net fields in the regions marked II and III. (5)

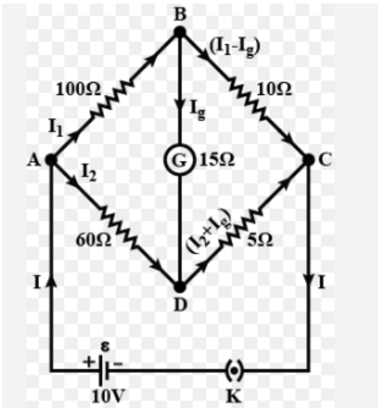


(b) A spherical conductor of radius 12 cm has a charge of 1.6×10^{-7}C distributed uniformly on its surface. What is the electric field (i) inside the sphere (ii) just outside the sphere (iii) at a point 18 cm from the centre of the sphere?

OR

(a) Derive the balance condition of wheatstone bridge circuit.

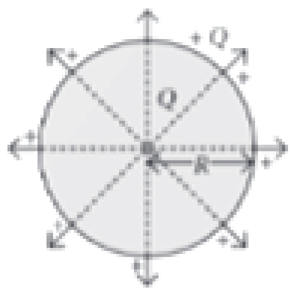
(b) The four arms of a Wheatstone bridge have the following resistances:
AB = 100 Ω, BC = 10 Ω, CD = 5 Ω, and DA = 60 Ω.
A galvanometer of 15 Ω resistance is connected across BD. Calculate the current through the galvanometer when a potential difference of 10 V is maintained across AC.



SECTION E

19. Read the following passage and answer the questions that are given below:

Spherical Capacitor:
The electrical capacitance of a conductor is the measure of its ability to hold electric charge. An isolated spherical conductor of radius R has charge Q uniformly distributed over its surface. It can be assumed to be concentrated at the centre of the sphere.



The potential at any point on the surface of the spherical conductor will be

$$V = \frac{1}{4\pi\varepsilon_0}\frac{Q}{R}$$

Capacitance of the spherical conductor in vacuum is C = Q/V

$$C = \frac{Q}{\frac{1}{4\pi\varepsilon_0}\frac{Q}{R}} = 4\pi\varepsilon_0 R$$

Clearly the capacitance of the spherical conductor is proportional to its radius R.

(i) The dimensions of capacitance is ___________ (1)

(A) $[ML^{-2}T^4A^2]$ (B) $[M^{-1}L^{-2}T^3A]$ (C) $[M^{-1}L^{-2}T^4A^2]$ (D) $[M^0L^{-2}T^{-4}A]$

(ii) What is the ratio of the capacitances of two spherical conductors of radii 2 m and 3 m respectively? (1)

(iii) Calculate the radius of a spherical conductor whose capacitance is 1F. (1)

OR

How much charge should be given to a spherical conductor of capacitance 25 pF to raise its potential to 10^5 V?

(iv) A metallic sphere of radius R is charged to potential of V. Then the charge q is proportional to (1)

(A) V (B) R (C) both V and R (D) neither V nor R

20. In materials, notably metals, some of the electrons are practically free to move within the bulk material. These materials, generally called conductors, develop electric currents in them when an electric field is applied. An electron will suffer collisions with the heavy fixed ions, but after collision, it will emerge with the same speed but in random directions. If we consider all the electrons, their average velocity will be zero since their directions are random. Consider now the situation when an electric field is present. Electrons will be accelerated due to this field. The electrons move with an average velocity which is independent of time, although electrons are accelerated. This is the phenomenon of drift and the velocity $\left(V_d = -\frac{eE}{m}\tau\right)$ is called the drift velocity. τ is known as relaxation time. Because of the drift, there will be net transport of charges across any area perpendicular to E. The current passing through the conductor will be $I = neAv_d$.

(i) What is relaxation time? (1)

(ii) How does the drift velocity vary as the temperature is increased? (1)

(iii) A conductor connected across a potential difference V is stretched double its length. What will be the drift velocity if the conductor is connected across the same potential difference? (2)

OR

(iii) What is current density? Give its expression in terms of drift velocity.